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Case Number: T 0087/10 - 3.4.02

Application Number: 04816765.4

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Language of the proceedings: EN

Title of invention:
Y-BRANCH-BASED THERMO-OPTIC DIGITAL OPTICAL SWITCHES AND VARIABLE OPTICAL ATTENUATORS WITH NON-UNIFORM HEATING

Applicant:
Enablence Technologies USA Inc.

Headword:

Relevant legal provisions:
EPC Art. 54, 56, 123(2)

Keyword:

Decisions cited:

Catchword:

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Beschwerdekammern
Boards of Appeal
Chambres de recours

European Patent Office
D-80298 MUNICH
GERMANY
Tel. +49 (0) 89 2399-0
Fax +49 (0) 89 2399-4465

Case Number: T 0087/10 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of19 February 2013

Appellant: (Applicant)	Enablence Technologies USA Inc. 400 March Road Ottawa, ON K2K 3H4 (CA)
Representative:	McKechnie, Neil Henry Harrison Goddard Foote Delta House 50 West Nlle Street Glasgow G1 2NP (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted 3 August 2009 refusing European patent application No. 04816765.4 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: A. Klein
Members: F. Maaswinkel
D. Rogers

Summary of Facts and Submissions

I. The appellant lodged an appeal against the decision of the examining division, refusing the European patent application 04 816 765.4. This patent application relates to a 1 x 2 Y-branch thermo-optic switch and a method for splitting an optical signal.

In the decision objections were raised under Art. 123(2) EPC and Art. 84 EPC 1973 against claims 1 of the main request and the auxiliary request then on file. In addition, the subject-matter of these claims were considered to lack novelty over the disclosure in document D1. Furthermore document D3 was referred to as relevant for the issue of novelty of the subject-matter of the independent claims and also for inventive step.

D1: PATENT ABSTRACTS OF JAPAN vol. 1997 no. 12, 25 December 1997 & JP-A-9 211501;
D3: PATENT ABSTRACTS OF JAPAN vol. 2000 no. 12, 3 January 2001 & JP-A-2000 241838.

With the letter of 27 October 2006 the applicant had provided translations of these documents.

II. With the letter containing the grounds of appeal the appellant requested to set aside the decision and to grant a patent on the basis of the sets of claims according to a main and a first auxiliary request filed with this letter. The appellant also filed an auxiliary request for oral proceedings.

III. In a communication pursuant to Rule 100(2) EPC the board raised objection under Article 123(2) EPC against

the sets of claims of both requests, since, whereas the appellant had explained in its letter that the independent claims had been amended to define the features of the embodiments of Figs. 5A and 5B, it appeared that some of the features in the actual set of claims did not correspond to this embodiment and that there was no basis in the original application documents.

IV. With a letter dated 16 November 2012 the appellant filed a replacement set of claims and amended description pages including the following application documents for consideration by the board:

Claims: 1 to 20, filed with the letter dated 16 November 2012;
Description: pages 4, 5, 9, 10 and 11 filed with the letter dated 16 November 2012;
pages 1 to 3, 6 to 8 and 12 to 14 as published under the PCT;
Drawings: sheets 1/6 to 6/6 as published under the PCT.

V. The wording of independent claim 1 reads as follows:

" A 1 x 2 planar optical waveguide signal splitter in the form of a Y-branch comprising a trunk and two branches conjoined thereto to form a vertex, said branches diverging from one another, each of said branches having a surface and an end, at least one of said branches being provided with a heater disposed along the waveguide surface, the heater having a length between first and second ends thereof and a narrowest point therebetween,

characterized in that the heater has a cross-sectional area that continuously narrows along the heater in going from the first end to the narrowest point thereof, reaching a minimum at the narrowest point, and continuously widens along the heater in going from the narrowest point to the second end thereof, the narrowest point of the heater being proximate to the vertex and being disposed with respect to said at least one of said braches such that upon activation of said heater, a spatially non-uniform heat flux incident upon the at least one of said branches is created, the heat flux increasing continuously in going from the end of the at least one of said branches to the vertex, reaching a maximum at a maximum point disposed proximate to the vertex, and continuously decreasing in going from the maximum point towards the trunk ".

The wording of independent claim 9 reads as follows:

" A method for splitting an optical signal, the method comprising:

(a) disposing in the propagation path of a propagating optical signal a 1 x 2 planar optical waveguide signal splitter in the form of a Y-branch comprising a trunk and two branches conjoined thereto to form a vertex, said branches diverging from one another, each of said branches having a surface and an end, at least one of said branches being provided with a heater disposed along the waveguide surface, the heater having a length between first and second ends thereof and a narrowest point therebetween, the heater having a cross-sectional area continuously narrowing along the heater in going from the first end to the narrowest point thereof, reaching a minimum at the narrowest point, and continuously widening along the

heater in going from the narrowest point to the second end thereof, the narrowest point of the heater being disposed proximate to the vertex,
said heather [*sic*] being disposed with respect to said at least one of said branches such that upon activation of said heater, a spatially non-uniform heat flux incident upon said at least one of said branches is created, the heat flux increasing continuously in going from the end of at least one of said branches to the vertex, reaching a maximum at a maximum point disposed proximate to the vertex, and continuously decreasing in going from the maximum point towards the trunk; and

(b) energizing said heater to effect the imposition of a spatially non-uniform heat-flux upon the surface of said at least one of said branches in order to effect a rise in the temperature of said at least one of said branches an amount sufficient to cause a change in the relative intensity of the propagating optical signal in the two said branches ".

Claims 2 to 8 and claims 10 to 20 are dependent claims.

VI. The appellant's arguments may be summarised as follows:

The claims have been amended to address the embodiments in Figures 5A and 5B. The basis for the amendments is further found on page 10, lines 22 - 37 of the application as published.

The appealed decision stated at page 4, item 1, that claim 1 of the main request filed on June 19, 2009 was not allowable under Art.123(2) EPC since there was no unambiguous hint in the application as filed, "*firstly, that the decrease of the heat flux after the narrowest point of the heater could be dropped from the embodiment wherein the heater is in the shape of a bow-*

tie and, secondly, that the claimed heat-flux distribution could be obtained in any other way than by means of the bow-tie shape of the heaters". With respect to the first objection claim 1 has been amended such that it now recites that "the heater has a cross-sectional area that continuously narrows along the heater in going from the first end to the narrowest point thereof, reaching a minimum at the narrowest point, and continuously widens along the heater in going from the narrowest point to the second end thereof", and "the heat flux increasing continuously in going from the end of the at least one of said branches to the vertex, reaching a maximum at a maximum point disposed proximate to the vertex, and continuously decreasing in going from the maximum point towards the trunk". Thus, claims 1 and 9 now specify that the heat flux decreases after the narrowest point of the heater. With respect to the second objection it is submitted that page 10, lines 22-26, immediately preceding the lines 26-30, reads: "In a preferred embodiment of the present invention, a heater wherein the cross-sectional area thereof is not constant is disposed along the length of the output waveguides". The text continues: "In a more preferred embodiment, the heater is in the shape of a bow-tie". First, a heater with a non-uniform cross-section is taught, then, a bow-tie type of the heater is taught. Further, page 11, lines 11-14, reads: "There is no limit according to the present invention to the possible heater designs, the number of ways the heater can be disposed with respect to the waveguide, or the combinations thereof with each other in order to practice the present invention". Therefore, a skilled person reading lines 22-30 of page 10 will realize that many shapes are possible and a particular triangular bow-tie shape is just an example of a shape having a narrowest point. Therefore, the heater defined by

amended claim 1 is not a generalization beyond the scope of the description, but to the contrary, is a particular case illustrated by, but not limited by, a triangular bow-tie. Limiting the scope of the invention to a particular embodiment is a matter of the applicant's choice (*Guidelines for Examination in the EPO, C III 4.3. (ii)*). The amended set of claims is thus admissible under Art. 123(2) EPC.

In point 2 of the decision claim 1 has been objected under Art. 84 EPC 1973 as lacking clarity due to the expressions "long dimension", "in close proximity to", "heating profile", and "spatially non-uniform heat flux". In order to overcome these objections claims 1 and 9 have been amended as follows:
- the term "heating means" having "long dimension" has been replaced with the expression "a heater having a length between first and second ends thereof and a narrowest point therebetween";
- the term "in close proximity to" has been replaced with the term "proximate to" to avoid using a relative term "close";
- the term "heating profile" has been removed; and
- the recitation "spatially non-uniform heat flux" has been clarified by reciting in claims 1 and 9: "the heat flux increasing continuously in going from the end of the at least one of said branches to the vertex, reaching a maximum at a maximum point disposed proximate to the vertex, and continuously decreasing in going from the maximum point towards the trunk".

With respect to the novelty objections based on document D1, it is noted that this document does not disclose a heater having a cross-sectional area that continuously narrows along the heater in going from the first end to the narrowest point thereof, reaching a

minimum at the narrowest point, and continuously widens along the heater in going from the narrowest point to the second end thereof. Indeed, in FIG. 4 of D1 the area 53 has substantially uniform cross-section, which does not meet the requirement of "continuously widening" and "continuously narrowing" as defined by claim 1. Similar considerations apply to claim 9. Thus, the subject-matter of claims 1 and 9 is novel over D1. This similarly applies to document D3 which does not disclose a heater having a cross-sectional area that continuously narrows along the heater in going from the first end to the narrowest point thereof, reaching a minimum at the narrowest point, and continuously widens along the heater in going from the narrowest point to the second end.

As to inventive step (Art.56 EPC), document D1 represents the closest prior art since it discloses that the heater having non-uniform cross sectional area can be disposed on at least one of the branches, whereas document D3 discloses that the heater having non-uniform cross sectional area is disposed on the surface of the trunk. The device defined in claim 1 differs from the switch in D1, Figure 4, in that the heater has a cross-sectional area that continuously narrows along the heater in going from the first end to the narrowest point thereof, reaching a minimum at the narrowest point, and continuously widens along the heater in going from the narrowest point to the second end thereof. The effect achieved by this difference is a gradual increase of the waveguide temperature as one approaches the vertex (see page 9, 1.11-18 of the published application). In the device of D1 the second heating part (53) of the heating means has a constant cross-sectional area and is arranged on top of the waveguide, therefore there is no gradual increase in

heat proximate to the vertex. According to paragraph [0029], last sentence of the translation of D1, the right-side heater, when energized, lowers the refractive index to the right of the waveguide W, effectively forming a thermally induced cladding for the waveguide W. Since it is generally known that a waveguide, in order to have a low loss, should be uniform, the skilled artisan would be led away from attempting to create a heater having constantly increasing or decreasing heat fluxes and cross-sectional areas, as defined by claims 1 or 9. Therefore, the subject matter defined by these claims involves an inventive step in view of D1. Also a combination of documents D1 and D3 does not lead to the solution of the invention in an obvious manner, since document D3 discloses a heater having a constant cross-section area along the branches. It thus teaches a heater providing a uniform heating profile to the surface of the branches. Thus, the skilled person would not be motivated to modify the sectional area of the splitter of D1 such that the cross sectional areas narrow until the areas reach the narrowest portion disposed in close proximity to the vertex. Therefore, the subject matter of claims 1 and 9 is not obvious and involves an inventive step over the cited prior art.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

2.1 In the decision an objection under Article 123(2) EPC was raised because in claim 1 some of the features of a particular embodiment had been inserted ("*the cross-*

sectional areas narrow until the areas reach the narrowest portion disposed in close proximity to the vertex", which relates to the embodiment illustrated in Figure 5A and 5B), without, however, simultaneously defining the further features of this embodiment (*namely: "the cross-sectional area increases again after the narrowest point*"). In the assessment of the examining division, this amendment involved an intermediate generalisation of this embodiment, contrary to the requirements of Art. 123(2) EPC.

2.2 Apart from the definition of the geometric shape of the heater before the narrowest point (*as in the former claims*) the present independent claims 1 and 9 include in addition the further characteristics of the heater after its narrowest point, thereby defining the entire geometrical shape of the heater. As a result of selecting this shape, the heat flux disposed along the length of the waveguide is non-uniform as disclosed in more detail at page 10, from line 22 of the published application.

2.3 The board concurs with the appellant that it may not be concluded from the passage of the description on page 10 that, in order to impose the non-uniform heat flux upon the waveguide, the heater necessarily must be in the shape of a bow-tie. Rather, the sentence in lines 27 – 30 in this paragraph according to which the heater may have a shape of a bow-tie, is understood as an example illustrating the general geometric shape in order to obtain the desired non-uniform heat flux. Neither this paragraph, which speaks of a "more preferred embodiment", nor the remainder of the original application documents discloses or suggests that the non-uniform heat flux may only be obtained by a heater having a bow-tie shape.

2.4 Therefore it appears that the subject-matter of the present independent claims does not extend beyond the content of the application as filed (Article 123(2) EPC).

2.5 With respect to the objections relating to Article 84 EPC in point 2 of the decision the board is satisfied that the amendments introduced by the appellant in claim 1 (and claim 9) and discussed in its grounds of appeal overcome these objections.

3. *Patentability*

3.1 *Novelty*

3.1.1 In the decision under appeal an objection on lack of novelty with respect to document D1 as well as D3 against claim 1 then on file was raised.

3.1.2 Figure 4 of document D1 discloses a 1 x 2 planar optical waveguide signal splitter in the form of a Y-branch with the technical features of the preamble of claim 1, in particular including a heater (52, 53) disposed along the waveguide surface. The heater has a length between the first and second ends of wiring paths 51 and a narrowest point therebetween (closest point of sections 53).

3.1.3 Differing from the shape of the heater defined in claim 1, the heater in the arrangement in Figure 5 of document D1 comprises two sections, each having a constant width: a "low exoergic" section 52 having a width of 30µm and a "high exoergic" section having a width of 8µm, see the translation of document D1, paragraph [0049]. Therefore this heater does not

comprise a cross-section that continuously narrows and, after the narrowest point, continuously widens.

Document D3 discloses in Figure 1 a digital thermo-optic optical switch comprising a 1 x 2 planar optical waveguide signal splitter and a thin-film heater structure (15). As disclosed in paragraph [0021] of the translation of D3, the width of the heater is tapered (area B) from a maximum value W_1 to a minimum value W_0 which is reached near the branching point, after which the width remains constant (area C), as explained in paragraph [0018] "the thin film heater 15 sets fixed spacing mostly to the perpendicular direction". Therefore it is doubtful whether a "narrowest point" can be defined at all for this heater. In any case its cross-section does not "continuously widen".

3.1.4 Hence the subject-matter of claim 1, and similarly that of claim 9, is novel over the disclosures in documents D1 and D3.

3.2 *Inventive step*

3.2.1 From the above assessment of documents D1 and D3 it appears that D1 can be considered as the closest prior art since it discloses in its Figure 4 the concept of shaping the heater electrodes with two different cross-sectional areas of which the portion near the waveguide vertex has the smallest, but constant, width.

3.2.2 The signal splitter defined in claim 1 of the appellant's request differs from the arrangement in Figure 4 of document D1 in that the heater has a cross-sectional area that continuously narrows along the heater length in going from the first end to the narrowest point thereof, reaching a minimum at the

narrowest point, and continuously widens along the heater in going from the narrowest point to the second end thereof, the narrowest point of the heater being proximate to the vertex. According to the description, see page 10, lines 30 – 36, this shaping of the heater electrodes results in a continuous increase of the heat flux along the long dimension of the heater until it reaches a peak at the narrowest point, which is disposed proximate to the vertex, thereby subjecting the region of the vertex to the highest temperature.

3.2.3 In contrast document D1, see paragraph [0029], teaches that by reducing the electrode width by half increases the generation of heat by a factor of four, but at the same time teaches to shape the exoergic section 52 with a constant but much smaller width than the outer sections 52 (8µm versus 30µm). Therefore the technical concept underlying the arrangement in document D1 is the idea that by this shaping of the heater electrodes the heat can be applied more efficiently, which also improves the working speed of the device (see paragraph [0020], last sentence). As a consequence of giving the inner (exoergic) section a constant width, the heat profile along this section is uniform.

3.2.4 The technical problem underlying the different geometry of the device of claim 1 can therefore be seen in offering an alternative technical solution, based on the concept of shaping the heater electrodes in order to maximise the heat flux at a point near the vertex, in other words: in creating a non-uniform heat profile.

3.2.5 Starting from document D1, or –alternatively- from document D3, it would not appear obvious to shape the heater electrodes in the way as defined in claim 1,

since both documents rely on the effect of optimising the heat flux near the waveguide branches in order to render the switch more efficient, but simultaneously impose the condition that the width of the heating section is constant, thus ensuring a homogeneous heating profile. Stated differently, in these documents it is recognised that it is advantageous to reduce the width of the heating electrodes near the switching point or vertex for minimising the required heat flux for switching, but these teachings rely on still having a uniform heat flux near the vertex. Neither these documents, nor the further documents cited in the International Search Report or examining proceedings, disclose or hint at the particular shaping of the electrodes as defined in claim 1.

3.2.6 This similarly applies to the method defined in claim 9. It is concluded that the subject-matter of claims 1 and 9 involves an inventive step and defines patentable subject-matter.

3.2.7 Claims 2 to 8 and claims 10 to 20 are dependent claims and are equally allowable.

4. For the above reasons, the board finds that the appellant's Request meets the requirements of the EPC and that a patent can be granted on the basis thereof.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent based on the following documents:

   Claims: 1 to 20, filed with the letter dated 16 November 2012;
   Description: pages 4, 5, 9, 10 and 11 filed with the letter dated 16 November 2012;
   pages 1 to 3, 6 to 8 and 12 to 14 as published under the PCT;
   Drawings: sheets 1/6 to 6/6 as published under the PCT.

The Registrar: The Chairman:

M. Kiehl A. G. Klein

Decision electronically authenticated